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THE CLASSIFICATION OF THE WAVERLY SERIES OF CENTRAL OHIO[1]

INTRODUCTION

PERHAPS it may seem strange that a consideration of the classification of the Waverly series[2] is proposed after the thorough investigations of the Ohio Geological Survey directed by Doctors Newberry and Orton. Their investigations gave the world the main facts concerning the economic and general geology of the state and the names of Newberry and Orton will be associated for all time with the geology of Ohio as those of Mather, Emmons, Vanuxem, and Hall are with that of New York, and Henry D. Rogers and Lesley with that of Pennsylvania. It is true of geology, however, as of other sciences that the scope is constantly widening so that a restatement of facts or, perhaps, another investigation of the whole subject, aided by later discoveries, may be required. At present this is especially true with reference to the stratigraphical geology of America. During the lifetime of Dr. Newberry the nomenclature of geological formations was not closely scrutinized and there were very few clearly defined rules governing the naming of the various geological divisions. In general, the names referred to some locality in which the rocks were more or less favorably exposed. But this was not always the case, for not infrequently mineralogical or paleontological terms were used for the names of the divisions. Much the same system prevailed during the period of the more active investigations of Dr. Orton and it is only during the last few years that the movement has arisen to place the nomenclature of stratigraphical geology on a basis similar to that of the biological sciences. Two of the most potent influences in this movement are the International Congress of Geologists and the United States Geological Survey. The most important principles of nomenclature governing the United States Survey are: first, a formation is a lithological unit representing the physical conditions of deposition, and should be called by the same name so far as it can be traced and identified by means of its lithologic characters aided by its stratigraphic associations and its contained fossils. The formation shall receive a distinctive designation, the preferred form being binomial of which the first member is geographic and the other lithologic. When the formation, however, consists of beds differing in lithologic character, so that no single lithologic term is applicable, the word "formation" shall be substituted for the lithologic term. The second principle is the rule of priority.[1] These two principles of nomenclature have been very imperfectly observed in most of our stratigraphical geology and as recently as December 1899, Dr. J. M. Clarke, state paleontologist of New York, and Mr. Charles Schuchert published a revised classification of the formations of New York in which a number of time-honored names were replaced by new terms.[2]

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[1] Published by permission of Professor Edward Orton, Jr., state geologist of Ohio. Presented to the tenth meeting of the Ohio State Academy of Science, Columbus, December 27, 1900.

[2] Series is used in the sense proposed by the International Congress of Geologists. See Work Inter. Cong. Geologists, 1886, p. 50; GILBERT, in Proc. A. A. A. S., Vol. XXXVI, 1888, p. 186; and Congrès Géologique International (8e Session), Procès-verbaux des Séances, 1901, p. 34.

REVIEW OF FORMER CLASSIFICATIONS

In 1838 Professor C. Briggs, Jr., the fourth assistant geologist of the first geological survey of Ohio, proposed the name

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[1] Tenth Ann. Rept. U. S. Geol. Surv., 1890, pp. 64, 65.

[2] Science, N. S., Vol. X, 1899, pp. 874–878.

"Waverly sandstone series" for the rocks occurring between the "argillaceous slaty rock, or shale stratum," now known as the Ohio shale, and the "conglomerate" which lies at the base of the Coal-measures. Waverly is the name of the capital of Pike county in southern Ohio and Professor Briggs stated that "As some of the most beautiful stones that have been obtained were quarried at Waverly, we may, for the present, denominate these rocks the Waverly sandstone series."[1]

In the following report, for some reason, Professor Briggs used the term "fine-grained sandstone" in place of the Waverly in his descriptions of the geology of Hocking, Athens, and Crawford counties.[2]

In the first report of the Newberry survey, Dr. Newberry and Professor Andrews revived the name, "Waverly sandstone."[3] Professor Andrews stated that it consisted of "A group of sandstones and shales, measuring on the Ohio River 640 feet in thickness (from the black slate to the base of the sub-Carboniferous limestone in the Kentucky hills), [which] rests conformably upon the black slate."[4] He further described a stratum of bituminous black shale 16 feet in thickness, 137 feet above the base of the group to which he gave the name "Waverly black slate."[5] It was also stated that between the Coal-measures and Waverly in Hocking county was "a group of comparatively fine-grained, buff-colored sandstone," 133½ feet in thickness which was named the Logan sandstone."[6] Below the Logan sandstone was given 85 feet of rocks which were stated to be composed of fine-grained sandstones alternating with conglomerates and this division in some parts of the report is called the "Waverly conglomerate."[1] Professor Andrews identified these two divisions in the Licking Valley and stated that "at Black Hand, near the east line of Licking county, the conglomerate is probably fifty or sixty feet thick, and over it lies, as we follow the dip to the southeast toward Zanesville, the Logan sandstone group. The Logan sandstone, with its characteristic fossils, is found to extend to a point between Pleasant Valley and Dillon's Falls, on the Baltimore and Ohio Railroad."[2]

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[1] First Ann. Rept. Geol. Surv. Ohio, p. 80.

[2] Second Ann. Rept. Geol. Surv. Ohio, 1839, pp. 122, 130. See also his section of the strata of Ohio, facing p. 109. The same term was used by Mr. Foster, another assistant; see pp. 76 and 103, and, facing p. 73, his "Geological section along the National road from the Scioto River to the eastern line of Muskingum county."

[3] Geol. Surv. Surv. Ohio, Pt. I, Rept. Progress in 1869, 1870, p. 21; Pt. II, p. 65.

[4] *Ibid.*, Pt. II, p. 65.

[5] *Ibid.*, p. 66.

[6] *Ibid.*, p. 76. The "section on Hocking River" on the "map showing the Lower Coal Measures" at the close of this report gave the thickness of the Logan sandstone group as 144 feet.

Dr. Newberry stated that the Waverly group, as it was then called, "In the northern part of the state . . . . is much less homogeneous [than in the southern part], and is composed of the following elements:

	Feet
Cuyahoga shale (dove-colored shale and fine blue sandstone) - - - - - - - - - -	150
Berea grit (drab sandstone) - - - - - -	50
Bedford shale (red and blue clay shale) - - -	60
Cleveland shale (black bituminous shale)[3] - -	20–60."

This classification was repeated by Dr. Newberry in 1873 in his report on the geology of Cuyahoga county, with a revision of the thickness of the several divisions, as follows:

		Feet
Waverly group	Cuyahoga shale - - -	150–200
	Berea grit - - - -	60
	Bedford shale - - -	75
	Cleveland shale[4] - -	21–60

At a later date the Cleveland black shale was referred by Dr. Orton and some other geologists to the Devonian system. The same classification for the Waverly was given by Dr. Newberry in 1874 under his description of the Carboniferous system.[5] In this volume Professor N. H. Winchell reported numerous outcrops of the Berea grit succeeded by the Cuyahoga shales and sandstones in northern central Ohio in Crawford, Morrow, and Delaware counties.[1] This identification of Professor Winchell's is important because it carried correctly, for the first time, the Berea grit with the overlying Cuyahoga shale from northern Ohio to the central part of the state. Dr. Orton published the descriptions of the geology of Pike and Ross counties in this volume, and gave the following subdivisions of the Waverly series:

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[1] See p. 135 and explanation of the "section on Hocking River" on the "map showing the Lower Coal Measures."

[2] *Ibid.*, p. 79. Also see *ibid.*, Rept. Progress in 1870 [1871], p. 59.

[3] *Ibid.*, Pt. I, Rept. Progress in 1869, p. 21.

[4] Rept. Geol. Surv. Ohio, Vol. I, Pt. I, p. 184.

[5] *Ibid.*, Vol. II, Pt. I, p. 87.

At the base are from 80 to 100 feet of the *Waverly shales*,[2] a name apparently proposed by him. This was followed by what he termed the *Waverly Quarry System*, with a thickness of 32½ feet, one mile south of Jasper.[3] Immediately above the sandstone is a black shale, from 16 to 27 feet in thickness, which, Dr. Orton stated, had been "designated by the chief geologist the '*Cleveland shale* and by Professor Andrews the '*Waverly black slate;*'"[4] while the remaining part of the series, including everything "above the Waverly black slate and below the Carboniferous series" was denominated the Upper Waverly, composed of shales and sandstones with a maximum thickness not exceeding 425 feet.[5]

Meek in 1875, in giving the horizon of *Discina* (*Orbiculoidea*) *Newberryi* Hall, stated that certain specimens came "from the Berea shale, a member of the Waverly group of the Lower Carboniferous,"[6] which is, apparently, the first usage of the name in a stratigraphical sense, although it does not clearly appear that Meek intended to separate the shale from the subjacent Berea grit.

In 1878 Dr. Orton's "Report on the geology of Franklin county" was published, and in it occurs a description of the Waverly group as far as represented in the county. The Huron shale, the youngest formation of the Devonian system, was described as closing with "a red or chocolate-colored band, from

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[1] *Ibid.*, pp. 240, 259, and 280.

[2] *Ibid.*, p. 619. [3] *Ibid.*, p. 621. [4] *Ibid.*, p. 624. [5] *Ibid.*, p. 649.

[6] Rept. Geol. Surv. Ohio, Vol. II, Pt. II, Palæontology, p. 278. See also statements in explanation of Plate XIV.

15 to 20 feet in thickness." Outcrops of these red shales were mentioned as occurring at "Taylor's Station, in Jefferson township, and at several points in Mifflin township, on the eastern bank of Big Walnut Creek. One exposure in particular may be named, which is very conspicuous, viz., the one seen in the slate cliff, opposite Central College."[1]

Dr. Orton's correlation of the divisions of the Waverly was as follows:

		Feet
Waverly group of the sub-Carboniferous period	Cleveland shale - - -	15
	Waverly quarry system -	60
	Waverly shales[2] - - -	10–20

In the report above mentioned Dr. Orton said "the Cleveland shale of Dr. Newberry, the Waverly black shale of Professor Andrews . . . . is known at but a single locality in the county, viz., at Ealy's Mills, in Jefferson township, on the banks of Rocky Fork. From 10 to 15 feet of this formation are here shown within the compass of an acre."[3] Dr. Orton further stated that Professor Winchell was in error in correlating the sandstone at Sunbury, Delaware county, with the Berea grit, his statement being as follows: "The Sunbury stone is erroneously referred in Vol. I [Vol. II] to a higher division of the Waverly, viz., the Berea grit, but it certainly belongs to the lowest of the sandstone courses of this formation."[4] The same volume contains the "Report on the Geology of Licking County," by M. C. Read, who described therein the upper Waverly of that county. The oldest division noted by Read was the *Waverly conglomerate*, which was said to be "conspicuously exposed along the south bank of the Licking in Madison and Hanover townships, presenting abrupt, precipitous bluffs 20 to 40 feet high."[5] The conglomerate was succeeded by the "olive shales," which were said to occupy "an interval of 150 to 190 feet below the Carboniferous conglomerate,"[6] and were described as composed mainly of shales, but with some "strata of massive sandstone."

[1] Rept. Geol. Surv. Ohio, Vol. III, Pt. I, p. 638.

[2] *Ibid.*, p. 639.

[3] *Ibid.*, p. 642.

[4] *Ibid.*, p. 642.

[5] *Ibid.*, p. 360.

[6] *Ibid.*, p. 359.

In July 1878 Professor L. E. Hicks, of Denison University, announced "the discovery [of] an unmistakable outcrop of Cleveland shale [which] exists two miles east of Sunbury in Delaware county, southern [central] Ohio, on the land of Horace Whitney. It lies *above* the calcareous sandrock of the Sunbury quarries, which Professor N. H. Winchell, a special assistant of the Ohio geological survey, identified as *Berea grit.* My discovery *demonstrates* the incorrectness of that identification, and raises a strong presumption, amounting almost to a certainty, that he was equally wrong in respect to his Berea grit in Morrow and Crawford counties."[1] Professor Hicks made no reference to the classification of the Waverly and identification of the Cleveland shale in Franklin county by Dr. Orton, and on the other hand Dr. Orton did not mention Professor Hicks' papers in any of his publications so I am unable to state which article has priority. The September number of the same periodical contained a classification of the Waverly group in central Ohio by Professor Hicks, which was stated to include the rocks lying between the Huron shales and the base of the Coal-measures. The classification is as follows:

	Feet thick
5. Licking shales - - - - - - -	100–150
4. Black Hand conglomerate and Granville beds -	85–90
3. Raccoon shales - - - - - - -	300
2. Sunbury black slate - - - - - -	10–15
1. Sunbury calciferous sandrock[2] - - -	90–100

The following year Dr. Orton published a "Note on the Lower Waverly Strata of Ohio" in which for the first time the Waverly black shale of southern Ohio was correctly correlated with the black shale directly above the Berea grit in northern Ohio for which the name Berea shale was proposed. This furnished the key for the correct correlation, between northern and southern Ohio, of the lower formations of the Waverly series, which was summarized in the following table:

[1] Am. Jour. Sci., and Arts, 3d ser., Vol. XVI, p. 71.

[2] *Ibid.*, p. 216.

Northern Ohio	Southern Ohio
Cuyahoga shale - - 150–250 ft. Upper beds fossiliferous	Shale and sandstone - 300–400 ft. Upper beds fossiliferous
(Berea shale) - - - 10 ft. Included by Newberry with Cuyahoga	Waverly black shale - - 15 ft.
Berea grit - - - - 60 ft.	Waverly quarries and overlying blue shale - - - - 60 ft.
Bedford shale - - - 75 ft.	Waverly shale - - - 90 ft.
Cleveland shale	Great black shale[1]

In 1888 Dr. Orton published a general classification of the Waverly group which he considered as composed of the Bedford shale, the Berea grit, the Berea shale, the Cuyahoga shale, and the Logan group. The Cuyahoga shale, however, was restricted to the shales and fine-grained sandstones between the Berea shale and the base of the conglomerate and sandstone forming the upper part of the Waverly. This upper division was called the Logan group which was said to consist of the Waverly conglomerate and Logan sandstone of Andrews as found in Hocking, Fairfield, and Licking counties. To the north the olive shales of Read in Knox and Richland counties were correlated with the Logan sandstone.[2] The same classification was republished by Dr. Orton in his last report for the Ohio survey.[3]

In 1888 Professor C. L. Herrick, who had studied the paleontology and stratigraphy of the Waverly series of central Ohio more thoroughly than any of the former observers, published his conclusions. Professor Herrick had also studied the Waverly of northern and southern Ohio and rocks of similar age in Pennsylvania and western New York, so that his classification was not intended to be confined to the rocks of central

[1] *Ibid.*, Vol. XVIII, p. 139.

[2] Rept. Geol. Surv., Ohio, Vol. VI, pp. 33–42.

[3] *Ibid.*, Vol. VII, 1893 [1895], pp. 26–35.

Ohio. The upper part of the series he correlated with the formations of the Mississippi valley and two quite persistent conglomerate horizons were named Conglomerate I and II.[1]

The classification is as follows:

Cuyahoga or Waverly series	Logan	Keokuk, 100–150 ft. Burlington
	(Conglomerate II)	
	Kinderhook, 50–60 ft.	
	(Conglomerate I)	
Berea or Transition series (Western equivalent of Upper Chemung)	Waverly shale, 40 ft.	
	Berea shale, 200–400 ft.	
	Berea grit, 50–60 ft.	
	Bedford shale, 50 ft.	
	Cleveland shale (local), 50 ft.	

Erie shale,

Eastern or typical Chemung (lower part), 100 ft.[2]

In the above classification the Berea shale included Dr. Orton's Berea shale and all of his overlying Cuyahoga shale except its fossiliferous upper 40 feet which, extending to the base of Conglomerate I, was called the Waverly shale.

In 1889 Dr. Newberry stated that the Waverly group "where best seen, as in northeastern Ohio, ... is about 500 feet thick, and fills the interval between the Erie shale (Chemung) below and the Carboniferous conglomerate above."[3] The following classification of the Waverly group was given:

	Average thickness feet
1. Cuyahoga shale	230
2. Berea shale	20
3. Berea grit	60
4. Bedford shale	75
5. Cleveland shale[4]	50

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[1] Bull. Sci. Lab., Denison University, April 1888, Vol. III, p. 24; see also section on p. 26.

[2] *Ibid.*, December 1888, Vol. IV, pp. 105, 106. The zones of these formations with their characteristic fossils and thickness are given in detail on pp. 99–101.

[3] Mon. U. S. Geol. Surv., Vol. XVI. The Paleozoic Fishes of North America, p. 120.

[4] Loc. cit.

It will be noticed that Dr. Newberry accepted the separation of the Berea shale from the Cauyhoga shale; but did not accept the reference of the Cleveland shale to the Ohio shale. This point he discussed quite fully and stated that the union of the Cleveland, Erie, and Huron shales to form the Ohio shale seemed unwarranted.[1] Dr. Newberry referred to Professor Hicks announcement of the discovery of the Cleveland shale in Delaware county, saying in conclusion: "I think he has found there the Berea shale, which lies immediately above the Berea grit."[2]

In 1891 Professor Herrick reviewed the general stratigraphy of the Waverly series, commencing with the Bedford shale. The lower boundary of the Waverly, however, he thought "must be found in the Berea grit, which . . . . is a sharply limited and easily recognizable horizon throughout Ohio."[3] The Berea grit came next, followed by the Berea shale, which, he states, is a term "conveniently applied to the thin band of bituminous shale above the grit, and perhaps should not be extended (as the writer has done in a previous paper) to the gray and blue shales above."[4] For the overlying rocks he used the name Cuyahoga shale in the sense in which it was used by Dr. Orton, except that the upper 40 feet, as in the previous paper, was called the Waverly shale. This division was stated to be stratigraphically continuous with the Cuyahoga shale which it also resembled lithologically, but paleontologically it more closely resembled the succeeding division or Kinderhook. The last division was called the Burlington and Keokuk.

REVISED CLASSIFICATION

This concludes the review of all the important papers published concerning the classification of the Waverly series of central Ohio. As a result of this study followed by an examination of the formations in the field, the writer proposes the following classification for the Waverly series of central Ohio.

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[1] *Ibid.*, p. 128.

[2] *Ibid.*, p. 129.

[3] Bull. Geol. Soc. Amer., Vol. II, p. 35.

[4] *Ibid.*, p. 35.

No attempt is made, however, to correlate the formations with those of the sub-Carboniferous of other states:

	Feet
6. Logan formation (Andrews)	115
5. Black Hand formation (Hicks)	40-(120?)
4. Cuyahoga formation (Newberry)	275-300
3. Sunbury shale (Hicks)	10-15
2. Berea grit (Newberry)	40
1. Bedford shale (Newberry)	85+

Bedford shale was named by Newberry in 1870[1] from the outcrops at Bedford, southeast of Cleveland, at which place, he later states, the best exposure occurs.[2] The term "Bedford rock" appears in Richard Owen's description of the geology of Lawrence county, Indiana, published in 1862;[3] but it was not used as the name of a geological division. This interpretation is apparently confirmed in the subsection of the report devoted to the general description of the sub-Carboniferous limestone where the term "Middle or Lawrence—Crawford sub-Carboniferous limestone"[4] is proposed, a name evidently employed to denote a geological division. Mr. E. R. Cumings, of Indiana University, informs me that the Bedford oölitic limestone belongs in this division.[5] Writers since Owen have used the terms "Bedford stone," "Bedford oölitic stone," and other names for the rock, which was finally excellently described in 1896 by Hopkins and Siebenthal under the formation name of the "Bedford oölitic limestone."[6] It is the opinion of the writer, however, that the term "Bedford shale" used by Dr. Newberry as the name of a formation in 1870 is the one that should stand and the Indiana formation name of Bedford oölitic limestone should be dropped. Since the above was written Mr. E. R. Cumings has proposed the name, Salem limestone, for the Bedford oölitic limestone of Indiana.[7]

[1] Geol. Surv. Ohio, Pt. I, 1870, p. 21.

[2] Rept. Geol. Surv. Ohio, Vol. I, Pt. I, 1873, p. 189.

[3] Rept. Geological Reconnoissance of Indiana during 1859 and 1860, p. 137.

[4] *Ibid.*, p. 125.

[5] Letter, January 13, 1901.

[6] Twenty-first Ann. Rept. Ind., Dept. Geol. and Nat. Resources, pp. 291, 298.

[7] Am. Geol., Vol. XXVII, March 1901, p. 147.

This formation succeeds the Ohio shale, and as the Cleveland and Erie shales are supposed not to extend to central Ohio it probably rests on the Huron shale in Franklin county. The lower part of the formation in this county is well shown on the eastern bank of Big Walnut Creek east of Central College where the following section occurs:

		Thickness feet	Total thickness feet
No. 7.	Till and soil - - - - - - -	5	87½
6.	Fine green argillaceous shale. *Bedford shale*	7	82½
5.	Mixed chocolate and greenish shale, mostly olive color - - - - - - -	7½	75½
4.	Chocolate shale composed of fine clay -	21⅔	68
3.	Fine green to olive argillaceous shales. Near base blocky shales containing fossils. *Base of Bedford* - - - - - -	17⅓	46⅓
2.	Fine black shales containing small concretions. *Huron shale* - - - - - -	24½	29
1.	Covered to level of Big Walnut Creek -	4½	4½

The greater part of the formation is shown on Rocky Fork, commencing about one and a half miles east of Gahanna and continuing up the creek for a mile. About one fourth mile up the creek from the ford on the north and south road is an outcrop, on the southern bank, of three feet of black shale which is nearly at the top of the Huron shale. A short distance farther up the creek is a higher bank which gives the following section:

		Thickness feet	Total thickness feet
No. 3.	Till - - - - - - - - - - -	6½	28¾
2.	Fine chocolate shales of the Bedford - -	7	22⅓
1.	*Bedford shales.* The upper part is somewhat sandy but the grains are very fine, and the lower part is composed of greenish to bluish argillaceous shale. Creek level - - -	15⅓	15⅓

At the second bluff to the west of the private bridge is the following section:

		Thickness feet	Total thickness feet
No. 2.	Till - - - - - - - - - - -	7⅔	36
1.	Chocolate argillaceous shale which weathers to a red clay. *Bedford shale.* Creek level -	28⅓	28⅓

To the east of the bridge the base of the till is much lower than on the western side and there is a marked line of unconformity between the till and Bedford shale. Two hundred and twenty-five feet east of the above section is the following, which shows an irregular surface on which the till was deposited:

		Thickness feet	Total thickness feet
No. 2.	Till with beds of sand	49⅓	54
1.	Bedford chocolate shale. Creek level	4⅔	4⅔

The covered interval between this bank and the next one is extensive enough to hide the top of the chocolate shale and the bluff is composed of grayish shales of the upper Bedford capped by the Berea sandstone. The following section is shown on the western bank of the creek below a tree:

		Thickness feet	Total thickness feet
No. 4.	Till	5	56½
3.	Grayish sandstone layers about one foot thick. *Berea sandstone*	14	51½
2.	Sandy, fine-grained shales with argillaceous ones above and below	9¾	37½
1.	At the top a sandy concretionary layer 2 ± feet thick. Shales mostly grayish and argillaceous. In the lower part are spots of reddish-gray shale somewhat similar to the mottled shale No. 5 east of Central College. Level of creek	27¾	27¾

The Bedford shale includes the red band from 15 to 20 feet in thickness, which Dr. Orton, in his report on Franklin county, considered the upper part of the Huron shale;[1] the gray shale between the red and black Huron shales which was not mentioned in the county report; and the Waverly shales.[2]

2. *Berea grit* was named by Dr. Newberry in 1870, from the large quarries at Berea, southwest of Cleveland.[3] It is well shown on Rocky Fork, to the north of the outcrops of the Bedford shale and on the banks of Big Walnut Creek about one mile northeast of Sunbury, Delaware county. There are beautiful examples of ripple marks in the sandstone at both of these localities. On the eastern bank of Rocky Fork is an exposure of 31½

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[1] *Ibid.*, Vol. III, Pt. I, p. 638.

[2] *Ibid.*, p. 639.

[3] Geol Surv. Ohio, Pt. I, p. 21.

feet of gray, thin bedded Berea sandstone, some of the layers a foot or more in thickness, with some partings of clay shale below which are 8 feet of bluish Bedford shales partly argillaceous and partly arenaceous, while in the upper part are thin layers of sandstone. The thickness of the Berea sandstone on this creek is about 40 feet and in the upper part at the highway is a small quarry. On the western bank of the Big Walnut between the railroad and highway bridges, one mile northeast of Sunbury, there is from 26 to 30 feet of it shown in the vertical cliff. This formation is called the "Waverly quarry system" in the report on Franklin county,[1] and the "Sunbury Calciferous sandrock" by Professor Hicks.[2]

3. *Sunbury shale* was named by Professor Hicks in 1878, from outcrops on Rattlesnake Creek on the present farm of Amos Whitney, about two miles east of Sunbury. North of the Whitney house there is an outcrop of 3½ feet of this black shale on the northern bank of the creek, and it may be seen at irregular intervals for some distance down the stream. A single specimen of a *Lingula* was the only fossil found, but the lower part of the shale is concealed and the top of the Berea grit crosses the creek a little below the house of Mr. W. P. Swallow. There is a much better exposure on Rocky Fork, in Franklin county, where the contact of the shale and Berea is shown just above the highway bridge on the David Meyers farm. The lower 2 feet of the very fossiliferous shale is exposed, containing abundant specimens of *Lingula melie* Hall, and *Orbiculoidea Newberryi* Hall, together with fragments of fish bones and teeth. Farther up the creek 8 + feet of the shale is shown on the western bank resting on the Berea grit.

This shale was first inappropriately named the "Waverly black slate" by Andrews in 1870[3] because the term Waverly had already been used for the larger division which includes this shale. Geological nomenclature is being revised for the purpose of eliminating and preventing the duplication of geographic names of stratigraphic divisions of the same or different rank. The name Berea shale, proposed by Dr. Orton in 1879,[1] is excluded, first, by the law of priority, since Sunbury shale was published and defined by Professor Hicks the preceding year, and second, because Berea had been used in 1870 by Dr. Newberry for the name of a formation. The division termed the Cleveland shales in the report on Franklin county is the Sunbury shale.[2]

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[1] *Ibid.*, Vol. III, p. 639.

[2] Am. Jour. Sci., 3d ser., Vol. XVI, p. 216.

[3] Geol. Surv. Ohio, Pt. II, 1870, p. 66.

4. *Cuyahoga formation* (shale) was the name given by Dr. Newberry in 1870[3] to "the uppermost member of the Waverly group" and was described as crossing Cuyahoga county and forming the banks of the Cuyahoga River to the Cuyahoga Falls.[4] Originally the Sunbury shale constituted the lower part of this formation, and in 1888 Dr. Orton separated the coarser deposits of conglomerate and sandstone in the upper part of the Waverly, as found in central and southern Ohio, from this formation, under the name of the Logan group,[5] and said this "upper member of the series [Waverly] is wanting in the Cuyahoga Valley, or is at least very inadequately represented there."[6]

Professor Herrick in 1891 from paleontological and stratigraphical evidence showed that this upper part of the Waverly is wanting in northern Ohio, and said: "We can positively assert that the Cuyahoga shale as represented in the northern tier of counties is identical with that part of the Waverly lying below Conglomerate I . . . . of central Ohio. The fossiliferous horizons of Granville, Newark, Rushville, and Winchell's Division 4, on the Ohio River, are all above the top of the Cuyahoga."[7]

Finally, Professor Herrick stated in 1893 that in the "northern localities the calcareous, concretionary layer, which has yielded so abundant a fauna in central Ohio, was discovered at a distance of 40 feet beneath the Coal Measure conglomerate and most of the characteristic species re-collected. This served to settle the question conclusively except for the few feet above this horizon."[1]

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[1] Am. Jour. Sci., 3d ser., Vol. XVIII, p. 138.

[2] Loc. cit., pp. 639, 642.

[4] Rept. Geol. Surv. Ohio, Vol. I, Pt. I, p. 185.

[3] Geol. Surv. Ohio, Pt. I, p. 21.

[5] *Ibid.*, pp. 37, 39.

[6] *Ibid.*, p. 39.

[7] Bull. Geol. Soc. America, Vol. II, p. 37. See also the section of Cuyahoga Valley and Bedford, on p. 40, where it is stated that "This entire series [upper part of the Waverly] is absent in the northern tier of counties to the base of Conglomerate I."

The present writer considers the Cuyahoga shales of central Ohio as composed of the shales and sandstones occurring between the top of the black Sunbury shale and the base of the coarse deposit called by Professor Herrick Conglomerate I. In this formation, therefore, is included the 40 feet of fossiliferous shales immediately underlying Conglomerate I of Professor Herrick which he called the Waverly shale.[2] Should a separation of this shale from the Cuyahoga prove necessary it would require a different name, because Waverly had already been used—first, as the name of a series; second as the name of the conglomerate in central and southern Ohio; third, as the name of the black shale in southern Ohio; fourth, as the name of the sandstone in the vicinity of Waverly; and fifth, the identical term Waverly shale by Dr. Orton for the lowest division of the series in southern Ohio.[3]

This formation was called the Raccoon shales by Professor Hicks, who said: "It appears in force all along Raccoon Creek and its tributaries, and extends westward into Franklin and Delaware counties."[4] Its thickness was estimated by Professor Hicks as 300 feet, while Professor Herrick stated that "the Cuyahoga proper is never more than 200 feet thick."[5]

In central Ohio the Cuyahoga formation is composed largely of bluish to grayish shales and buff sandstones which are fairly well exposed on Moot's Run and other streams in the western and central parts of Licking county.

[1] Rept. Geol. Surv. Ohio, Vol. VII, 1893, pp. 502, 503.

[2] Bull. Denison Univ., Vol. IV, 1888, p. 107.

[3] Rept. Geol. Surv., Ohio, Vol. II, Pt. I, 1874, pp. 619, 648; and Figs. 1 and 2 of the report on Pike county.

[4] Am. Jour. Sci., 3d ser., Vol. XVI, 1878, p. 219.

[5] Bull. Geol. Soc. Amer., Vol. II, 1891, p. 38.

5. *Black Hand formation* (conglomerate) is the name given by Professor Hicks in 1878 to the deposits of coarse sandstone and conglomerate exposed at Black Hand in the gorge of the Licking River and about Hanover.[1] Both of these localities are in Hanover township, in the eastern part of Licking county. We find, as in the case of most conglomerates, that when this formation is followed for some distance there are quite decided differences in the lithologic character of the rocks. In the vicinity of Newark and Granville they are mainly sandstones, with some layers of shales and two comparatively thin strata of conglomerates. Professor Hicks states that these beds are well exposed at Granville and are only a local modification of the Black Hand conglomerate, and for convenience he designated them "the Granville beds."[2] Professor Andrews in 1870 called this division the Waverly conglomerate;[3] but this name was preoccupied, because Waverly had already been used for the name of the series. He correlated the conglomerate at Black Hand with that of the Waverly and gave its thickness at that locality as probably 50 or 60 feet.[4]

At Havens' quarries, on the farm of Mr. G. W. Havens, one and one half miles southeast of the central part of Newark, is a good exposure of the sandstone phase of this formation. The section begins in the conglomerate stratum on the bank of Quarry Creek below the quarries, where an excavation has been made in prospecting for gold, and continues to the top of the bank above the quarry on the eastern side of the run. The quarry on the western side of the creek is shown in Fig. 1, the lower part of which is in the Black Hand and the upper the Logan formation.

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[1] Amer. Jour. Sci., 3d ser., Vol. XVI, pp. 216, 217.

[2] *Ibid.*, p. 218.

[3] Geol. Surv. Ohio, Pt. II, p. 135, and on the explanation of the "Section on Hocking River" of the "Map showing the Lower Coal Measures."

[4] *Ibid.*, p. 79.

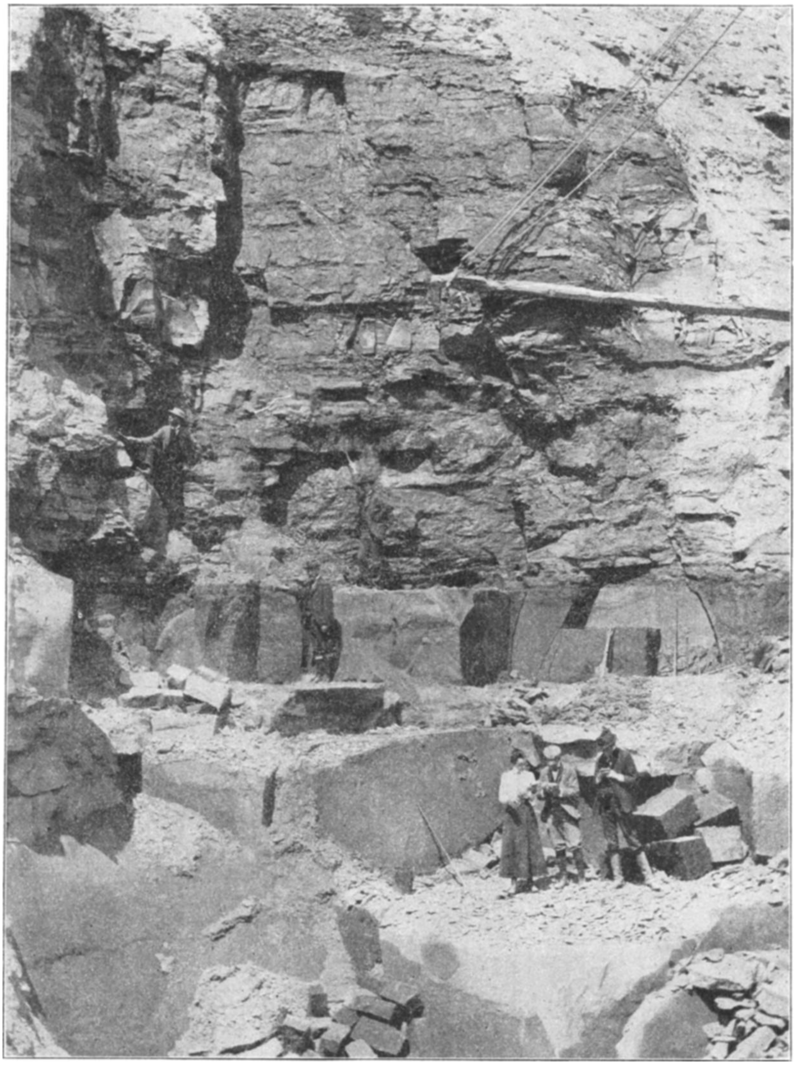

FIG. 1.—Havens quarry on the western bank of the stream. The lower part shows the massive sandstone of the Black Hand formation, the top of which is Herrick's Conglomerate II, indicated by the two upper students. Succeeding Conglomerate II the lower part of the Logan formation is shown.

SECTION AT HAVENS' QUARRY

		Thickness feet	Total thickness feet
No. 9.	Till and soil - - - - - - - - -	2	75
8.	Alternating shales and sandstone - - - -	14½	73
7.	Massive buff sandstone splitting into many layers - - - - - - - - -	16	58½
6.	Bluish argillaceous shales - - - - -	4½	42½
5.	Conglomerate stratum No. II of Herrick; average thickness 11 inches - - - - - -	1	38
4.	Bluish fossiliferous shales containing numerous specimens of *Spirophyton* and other fossils; was called the "Allorisma layer" by Herrick - -	6½	37
3.	Grit containing a few fossils - - - - -	½	30½
2.	Light gray to buff fine-grained sandstone, which is called freestone and quarried. This forms a massive zone which splits into several layers. The upper 8 feet of this zone is shown in this quarry, and, at the base in the gold-mine opening, nearly 3 feet of drab argillaceous shale, below which is 3¼ feet of coarse-grained buff sandstone. In the Havens quarry, on the western side of the creek, nearly 20 feet of this sandstone is shown, and in the Vogelmeier quarry, one and one half miles south of Newark, 27 feet of sandstone, separated by a 5-inch bluish shaly layer 9 feet below the top. In certain layers of this sandstone fossils are common, especially *Syringothyris cuspidatus* (Martin).		
1.	Conglomerate stratum, 3 feet thick. Sandstone parting, 7 inches. Massive conglomerate with quite large pebbles, which are coarser than in the upper layer. Level of creek (Conglomerate No. I of Herrick) - - - - - - - -	5	5

From the freestone No. II of the above section the following species were collected:

1. *Syringothyris cuspidatus* (Martin) (c).
2. *Spirifer Winchelli* Herrick.
3. *Crenipecten Winchelli* (Meek) (c).
4. *Platyceras Hertzeri* Winch (r).
5. *Chonetes pulchella* Winch (rr).
6. *Rhipidomella* (*Orthis*), cf. *Michelina* L'Eveillé (c).

7. *Cryptonella eudora* Hall (rr).
8. *Camarotœchia marshallensis* (A. Winch) ? (rr)

The Allorisma shales No. IV contain the following species:

1. *Allorisma ventricosa* Meek (rr).
2. *Sanguinolites* (?) *obliquus* Meek (r).
3. *Sanguinolites œolus* Meek (r).
4. *Sanguinolites* sp.
5. *Camarotœchia marshallensis* (Win.) (?) or *C. Cooperi* Shum. (?)
6. *Allorisma Winchelli* Meek (c).
7. *Sanguinolites naiadiformis* Winch. (r).
8. *Prothyris Meeki* (Winch) (r).
9. *Spirophyton* cf. *crassum* Hall (c).
10. *Syringothyris cuspidatus* (Martin) (rr).
11. *Liopteria* sp. (rr).
12. *Discina* (*Orbiculoidea*) *pleurites* (Meek) (?) (rr).

Professor Andrews did not definitely indicate the boundaries of the Waverly conglomerate; neither did Professor Hicks those of the Black Hand conglomerate and Granville beds. The thickness of the conglomerate near Hanover was given as from 85 to 90 feet,[1] and that of the Granville beds as from probably 25 to 111 feet.[2]

The Fucoid layer (No. 4c) of Hicks' Granville beds is the same as the "Allorisma layer" of Professor Herrick's and No. 4 of the Havens section. Division No. 2 of Professor Herrick's, which he called the Middle Waverly or Kinderhook, was clearly defined by Conglomerate No. I at the base and Conglomerate No. II at the top,[3] and by its fossils correlated with the Kinderhook formation of the Mississippi valley. This formation is apparently quite well marked by these two conglomerate strata in the vicinity of Newark, and Professor Herrick identified Conglomerate II in sections from Ashland county to Sciotoville on the Ohio River,[4] and later states that the Allorisma shale is "very persistent and well limited, even when the Conglomerate (No.

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[1] Am. Jour. Sci., 3d ser., Vol. XVI, p. 217.

[2] *Ibid.*, p. 218. The statement is not clear, and 85 feet possibly represents the minimum thickness.

[3] Bull. Denison Univ., Vol. IV, 1888, pp. 105, 106.

[4] *Ibid.* See sections on p. 102.

VOGELMEIER QUARRY, NEWARK, OHIO.

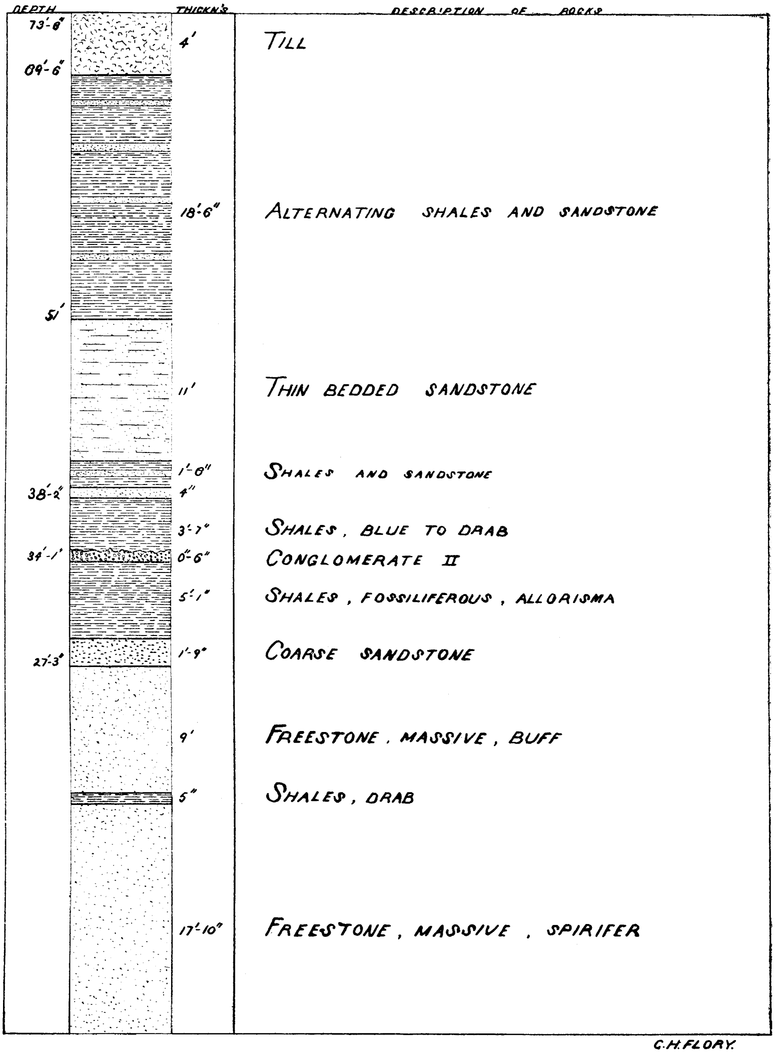

FIG. 2.—Section of Vogelmeier quarry, southeast of Newark, showing a part of the Black Hand and Logan formations. Conglomerate II is considered the line of division between them.

II) is absent, having been traced from Sciotoville to the northern exposures in Wayne county."[1] Conglomerate No. I seems less persistent than No. II, but below the freestone there are generally thick shales, so that the base of the formation is quite distinct stratigraphically.

In the vicinity of Hanover and in the gorge of the Licking River at Black Hand are excellent exposures of the conglomerate phase of the formation. Below Hanover, on the western side of Rocky Fork, is a fine cliff of the conglomerate 80 feet high, which is shown in Fig. 3, while apparently its top, as shown by partial exposures in the field above the brow of the cliff, is some 35 feet higher. Professor Hicks gave the thickness of the Black Hand conglomerate at Hanover as from 85 to 90 feet,[2] and Professor Herrick reported that in the region about Clay Lick station, in Hanover township, "is a great development of the conglomeratic phase of the Waverly. One half mile east of Clay Lick there is a nearly continuous exposure of about 100 feet of alternating conglomerate and coarse sandstone of prevailingly red color."[3]

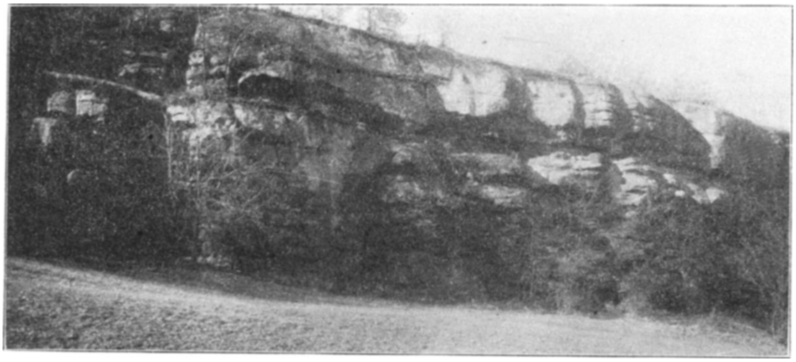

FIG. 3.—Ledge of Black Hand conglomerate below Hanover.

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[1] Bull. Geol. Soc. America, Vol. II, 1891, p. 38.

[2] Am. Jour. Sci., 3d ser., Vol. XVI, 1878, p. 217.

[3] Bull. Sci. Lab. Denison Univ., Vol. II, 1887, p, 15.

To the east of the Hanover railroad station is a cut in which the contact of the Black Hand conglomerate and overlying Logan sandstone is nicely shown. To the south of the cut and highway is the quarry of the Hanover Pressed Brick Co. in the shales of the Logan formation. The section from the railroad to the top of the quarry is as follows:

		Thickness feet	Total thickness feet
No. 4.	Mainly blue to drab argillaceous shales with some bands of sandstones which vary from 7 inches to perhaps a foot in thickness	20	92
3.	Covered	18	72
2.	Buff shaly thin bedded sandstones containing fossils which are well shown in the upper part of the railroad cut in the vicinity of the highway bridge. Lower part of the *Logan sandstone* which is separated by quite a sharp line from the massive grit to conglomerate below. There are some thin layers of conglomerate near the base of the Logan sandstone.	22	54
1.	Massive grit to conglomerate which forms the lower portion of the cut. Part of the rock is a buff grit and the remainder a conglomerate some of the pebbles of which are quite large.	32	32

BLACK HAND CONGLOMERATE

The Black Hand conglomerate named from the cliffs in the gorge of the Licking River, known as the Licking Narrows, begins a short distance above the station of Black Hand on the Baltimore and Ohio Railroad.[1] On the north side of the river rather more than a quarter of a mile above the bridge are two conspicuous cliffs, the lower one called Red Rock and the upper one Black Hand which is shown in Fig. 4. On the southern side of the river is a railroad cut which shows finely the contact of the Black Hand conglomerate and the Logan sandstone. To the west of the cut at a distance of about one half mile from the station is a prominent cliff in one part of which is the E. H.

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[1] For a description of the topography of this region and the former as well as the present gorge of Licking River, see Professor W. G. Tight's paper in Bull. Sci. Lab., Denison Univ., Vol. VIII, Pt. II, pp. 36–43, and Pls. I, II.

Evertts & Co. quarry for glass sand. The following section was measured at this locality from the level of Licking River to the top of the cliff.

SECTION OF SOUTHERN BANK OF LICKING RIVER AT EVERTTS & CO. QUARRY

	Thickness feet	Total thickness feet
No. 6. Till - - - - - - - - - -	7	101
5. Thin, irregular bedded, drab or bluish sandstone and bluish argillaceous shales. In places at the bottom is a 3-inch clay shale resting on the massive conglomerate with a sandstone to conglomerate layer above. Lower part of the *Logan sandstone* - -	22	94
4. A coarse conglomerate stratum at the top of the conglomerate which in places is 11 inches thick. The top of the *Black Hand conglomerate* - - - - - - - - -	1	72
3. Gray to drab coarse grit, which in places is a conglomerate that is worked for glass sand. This forms the upper part of the main cliff -	21	71
2. Coarse grit and conglomerate to the base of the cliff at the Crusher - - - - -	16	50
1. Mostly covered bank below the Crusher but all in the conglomerate as shown by exposures a little farther down the river. Level of Licking River - - - - - - -	34	34

6. *Logan formation* (sandstone) was named by Professor Andrews in 1870 from outcrops in Hocking county near Logan,[1] and was stated to overlie the conglomerate at Black Hand and to extend down the Licking Valley "to a point between Pleasant Valley and Dillons Falls."[2] This division was named the Licking shales by Professor Hicks, who states that they are well developed in the hills bordering Licking River from Newark to Black Hand, 100 to 150 feet in thickness, and "lie 70 to 80 feet above the water level, forming the middle of the slope of these hills, the base being composed of the massive Black Hand conglomerate and the upper slopes and summit of the various strata of the Coal

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[1] Geol. Surv. Ohio, Part II, pp. 76, 79.

[2] *Ibid.*, p. 79.

Measures."[1] This formation is Division 3, or the Upper Waverly of Professor Herrick, which he gave as 80 feet in thickness in Licking county and which, from the fossils, he correlated with the Burlington and Keokuk of the Mississippi valley.[2]

In 1888 Dr. Orton united the Waverly conglomerate and Logan sandstone of Andrews to form the Logan group.[3] If it be advisable to make one formation of these two divisions, the above name is inappropriate because the Logan sandstone of Professor Andrews clearly referred to the upper division only, as has been noted by Professor Herrick.[4]

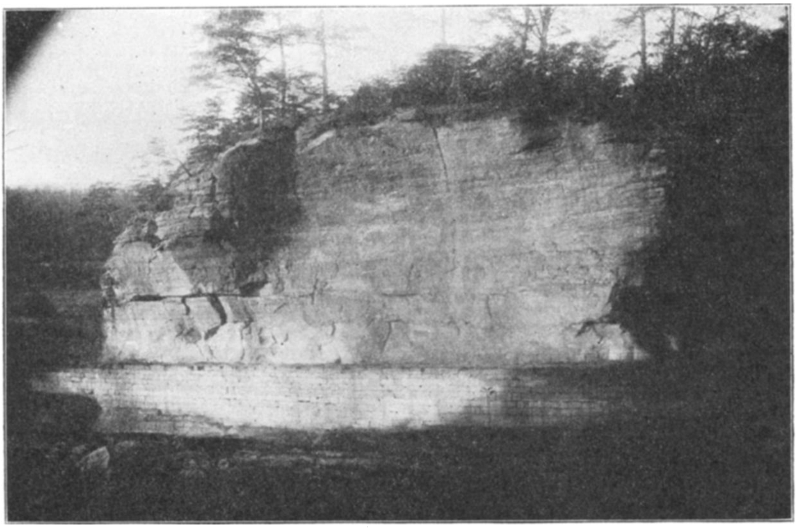

FIG. 4—Black Hand rock in the gorge of Licking River.

The above ruling is believed to represent the position of the United States Geological Survey, as shown by the following quotation from a recent letter of Mr. Bailey Willis, assistant in

[1] Am. Jour. Sci., 3d ser., Vol. XVI, 1878, p. 216.

[2] Bull. Denison Univ., Vol. IV, 1888, pp, 99, 100.

[3] Rept. Geol. Surv., Ohio, Vol. VI, p. 39.

[4] Bull. Geol. Soc. Amer., Vol. II, 1891, p. 38.

geology to the Director of the United States Survey and Geologist in charge of Areal Geology, to whom these questions in nomenclature are referred:

> The survey distinctly recognizes the right of priority, that is to say, the name first applied to a well defined geologic unit is to be preferred. The qualifying conditions, on account of which the name may be rejected and one of later application used, are (1) that the name has been previously applied to some other unit, and (2) that the unit to which the name was applied was not well defined.
>
> Thus, in the case which you cite, the term Waverly conglomerate (Andrews) would not hold if Waverly had previously been used for something else, and by application of the same rule Waverly series should be discarded if Waverly conglomerate had priority. The Logan group (Orton) should not stand as opposed to Logan sandstone.
>
> In these questions there is often a personal element which makes it a matter of regret that some desirable name should not be adopted, but we feel that the advantages of clearness and definition in science must be superior to such conditions, and that the rule should be rigidly applied.[1]

Dr. George H. Girty, of the United States Geological Survey, who has been engaged for several years in a thorough study of the stratigraphy and paleontology of the Waverly series in Ohio, Michigan, and Pennsylvania, concurs in regarding the upper part of the series in central Ohio as composed of two formations, as may be seen from the following quotation:

> I have seen the Logan group at Logan and vicinity and also at various points in Licking county. I quite concur with you in regard to the separateness of the two component members in central Ohio at least, and am in uncertainty as to the reasons which led Professor Orton to unite the two beds under a common name.[2]

The lower part of this formation is well shown in the Vogelmeier and Havens quarries, where Conglomorate II is succeeded by from 4½ to 6 feet of greenish-gray to bluish argillaceous shales, and these are followed by from 11 to 17 feet of quite massive buff sandstones, capped by alternating shales and sandstones, 18½ feet of which are shown at the top of the Vogelmeier quarry. There are fair exposures of the remaining part of the formation in "the gorge" to the east of the Havens quarry, partly in the bank of the creek and partly by the roadside, where 85 feet of buff arenaceous shales to thin bedded sandstones are shown. This gives about 115 feet for the thickness of the formation, which is capped by the Coal-measure conglomerate where the road and creek emerge from the woods. In sections farther to the south and southeast the top of the Logan sandstone is defined by the base of the sub-Carboniferous limestone, named by Professor Andrews the Maxville limestone.

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[1] Letter of December 18, 1900.

[2] Letter of January 5, 1901.

CHARLES S. PROSSER.

COLUMBUS, OHIO,
December, 1900.